EFFECTS OF MICROPLASTICS ON HUMAN HEALTH

MAC & NWWAC WORKSHOP ON MARINE PLASTICS AND THE SEAFOOD SUPPLY CHAIN
INTERPRETATION DIRECTORATE (SCIC), RUE DE LA LOI 102, BRUSSELS
7TH NOVEMBER, 2019

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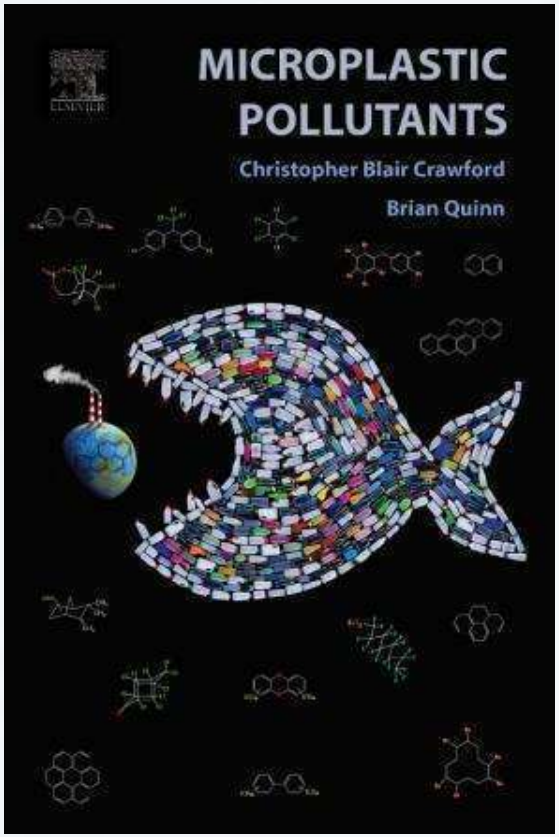
My Microplastics Research



Analytical Methods

PAPER

Optimisation of enzymatic digestion and validation of specimen preservation methods for the analysis of ingested microplastics

Winnie Courtene-Jones,*[a] Brian Quinn,[b] Fionn Murphy,[b] Stefan F. Gary[c] and Bhavani E. Narayanaswamy[d]

Environmental Science and Pollution Research
https://doi.org/10.1007/s11356-019-06501-3

RESEARCH ARTICLE

Detection of polystyrene nanoplastics in biological samples based on the solvatochromic properties of Nile red: application in *Hydra attenuata* exposed to nanoplastics

François Gagné[1] · Joëlle Auclair[1] · Brian Quinn[2]

Received: 11 April 2019 / Accepted: 10 September 2019

Analytical Methods

PAPER

Validation of density separation for the rapid recovery of microplastics from sediment

Brian Quinn,* Fionn Murphy and Ciaran Ewins

Contents lists available at ScienceDirect

Environmental Pollution

journal homepage: www.elsevier.com/locate/envpol

Consistent microplastic ingestion by deep-sea invertebrates over the last four decades (1976–2015), a study from the North East Atlantic☆

Winnie Courtene-Jones [a, *], Brian Quinn [b], Ciaran Ewins [b], Stefan F. Gary [a], Bhavani E. Narayanaswamy [a]

Contents lists available at ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

The uptake of macroplastic & microplastic by demersal & pelagic fish in the Northeast Atlantic around Scotland

Fionn Murphy[a,*], Marie Russell[b], Ciaran Ewins[a], Brian Quinn[a]

Contents lists available at ScienceDirect

Environmental Pollution

journal homepage: www.elsevier.com/locate/envpol

Microplastic pollution identified in deep-sea water and ingested by benthic invertebrates in the Rockall Trough, North Atlantic Ocean☆

Winnie Courtene-Jones [a, *], Brian Quinn [b], Stefan F. Gary [a], Andrew O.M. Mogg [a], Bhavani E. Narayanaswamy [a]

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My Microplastics Research

Contents lists available at ScienceDirect

Environmental Pollution

journal homepage: www.elsevier.com/locate/envpol

Microplastic pollution identified in deep-sea water and ingested by benthic invertebrates in the Rockall Trough, North Atlantic Ocean*

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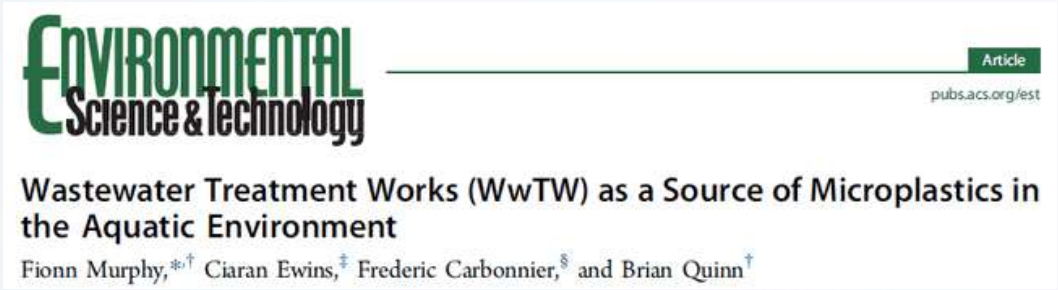


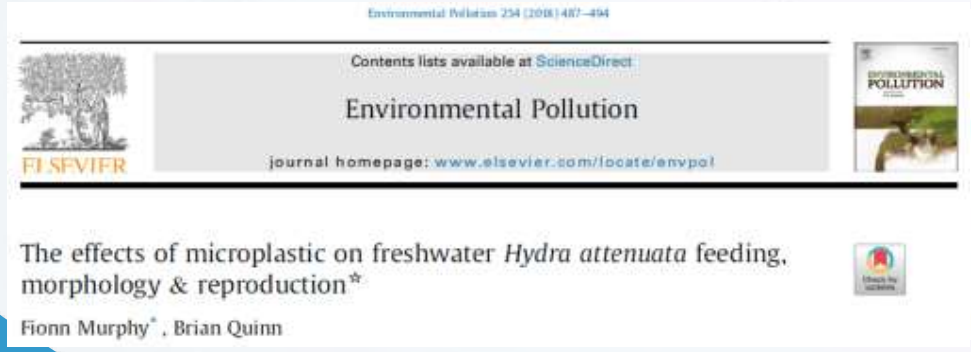
Environmental Science & Technology

Article

pubs.acs.org/est

Wastewater Treatment Works (WwTW) as a Source of Microplastics in the Aquatic Environment

Fionn Murphy,*[,†] Ciaran Ewins,[‡] Frederic Carbonnier,[§] and Brian Quinn[†]



Contents lists available at ScienceDirect

Environmental Pollution

journal homepage: www.elsevier.com/locate/envpol

The effects of microplastic on freshwater *Hydra attenuata* feeding, morphology & reproduction*

Fionn Murphy*, Brian Quinn

Current Opinion in Environmental Science & Health

Volume 7, February 2019, Pages 69-75

Microplastics in drinking water: A review and assessment

Dafne Eerkes-Medrano [1], Heather A. Leslie [2], Brian Quinn [3]

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Routes of human exposure to microplastics

1. Ingestion:

- Food




- Water


2. Inhalation: Air


3. Dermal Contact

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Microplastics in food: Ingestion

EFSA Journal

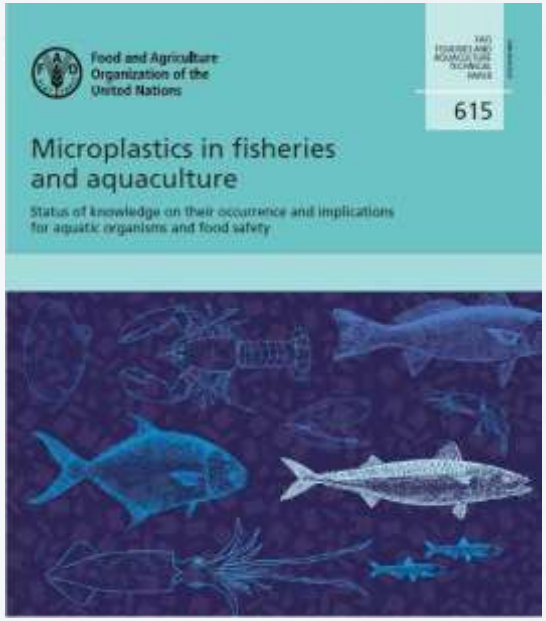
STATEMENT

ADOPTED: 11 May 2016

doi: 10.2903/j.efsa.2016.4501

Presence of microplastics and nanoplastics in food, with particular focus on seafood

EFSA Panel on Contaminants in the Food Chain (CONTAM)



seafish

Update on the sources, fate, effects and consequences for the Seafood Industry of microplastics in the marine environment

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Microplastics in food: Ingestion

Species	Location	Av No. MP / g soft tissue	Particle type	Reference
M. edulis	Germany (Aquaculture)	0.36 (±0.07)	Fragments, spheroids	Van Cauwenberghe & Janssen, 2014
C. Gigas	Germany (Aquaculture)	0.47 (±0.16)	Fragments, spheroids	Van Cauwenberghe & Janssen, 2014
9 different species	China (market bought)	4.0 (±2.1-10.5)	Fragments, fibres, pellets	Li et al., 2015
V. philippinarum	Canada (aquaculture)	1.13 (±0.66)	Fibres, film, fragments	Davidson & Dudas, 2016
M. edulis	Belgium	0.24	Fibres, fragments	De Witte et al., 2014
C. gigas	Belgium	0.35		
M. edulis	Scotland: Oban (wild)	1.05 (±0.66) – 4.44 (±3.03)	Fibre, film, fragments, beads	Courtene-Jones et al., 2016
Mytilus spp.	Industrial Estuary Scotland	0.74 (±0.125)	Fibres	Catarino et al., 2018
Mytilus spp.	Scotland: Various (wild)	3.0 (± 0.9)	Fibres	Catarino et al., 2018

Food type	Location	Av No MP/KG	Av No MP/g	Particle type	Reference
Honey*	Germany	166 ± 147	0.166 ± 147	Fibres, Fragments	Liebezeit et al., 2013.
Sugar*	Germany	249 ± 130	0.249 ± 130	Fibres, Fragments	
Sea salt	China	550–681	0.55-0.681	Fragments, fibres, pellets	Yang et al., 2015
Lake salt	China	43–364	0.043-0.364	Fragments, fibres, pellets	
Rock/well salt	China	7– 204	0.07-0.204	Fragments, fibres, pellets	
Salt	International	1-10	0.001-0.01	Fragments, filaments, films	Karami et al., 2017

Microplastics in Water: Ingestion

PLOS ONE

RESEARCH ARTICLE

Anthropogenic contamination of tap water, beer, and sea salt

Mary Kosuth[1]*, Sherri A. Mason[2], Elizabeth V. Wattenberg[1]

1 University of Minnesota, School of Public Health, Division of Environmental Health Sciences, Minneapolis, Minnesota, United States of America, 2 State University of New York at Fredonia, Department of Chemistry and Biochemistry, Fredonia, New York, United States of America

Water Research 141 (2018) 307–316

Contents lists available at ScienceDirect

Water Research

journal homepage: www.elsevier.com/locate/watres

Small-sized microplastics and pigmented particles in bottled mineral water

Barbara E. Oßmann [a, b, *], George Sarau [c, d], Heinrich Holtmannspötter [a, 1], Monika Pischetsrieder [b], Silke H. Christiansen [c, d, e], Wilhelm Dicke [a, **]

Science of the Total Environment 648 (2019) 631–635

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Low numbers of microplastics detected in drinking water from ground water sources

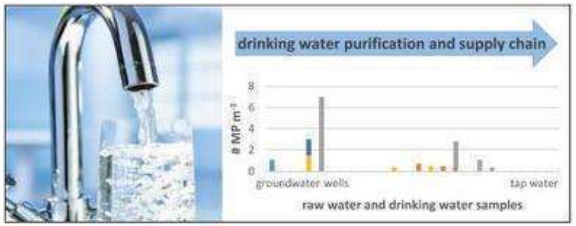
Mintenig S.M. *,1, Löder M.G.J. 2, Primpke S., Gerdts G.

Alfred-Wegener-Institut, Helmholtz-Zentrum für Polar- und Meeresforschung, Biologische Anstalt Helgoland, P.O. Box 180, 27483 Helgoland, Germany

HIGHLIGHTS

- Identification of microplastics >20 μm using FTIR imaging.
- Examination of 40 m^3 ground water and drinking water for microplastics.
- Negligible microplastic contamination of drinking water (<1 particle m^{-3}).

GRAPHICAL ABSTRACT



Water Research 129 (2018) 154–162

Contents lists available at ScienceDirect

Water Research

journal homepage: www.elsevier.com/locate/watres

Analysis of microplastics in water by micro-Raman spectroscopy: Release of plastic particles from different packaging into mineral water

Darena Schymanski [a, b], Christophe Goldbeck [a], Hans-Ulrich Humpf [b], Peter Fürst [a, *]

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Microplastics in Water: Ingestion

Reference	Type of DW measured (number of samples)	Volumes collected per sample	Min & max values; mean concentration	Size range of particles	Type of particles	Composition of particles
*Kosuth et al. 2018	Tap water (n=156), Bottled water (n=3)	500ml	0 to 60.9 particles/L; 5.45 particles/L	0.10-5.00mm, (Av.0.96mm)	Fibres, fragments, films	NA
Mintenig et al. 2018	Raw water at DWTP inlet (n=6), DW at DWTP outlet (n=5), DW at household water meter (n=5) and water tap (n=5), well ground water (n=3)	300-1000L raw water, 1200-2500L DW	0 to 7 particles/m3; 0.7 particles/m3 (14 of the 24 samples had no MP detected)	50-150µm	fragments, fibers were suspected as contaminatio n	PEST, PVC, PA, epoxy, and PE.
Oßmann et al. 2018	Mineral water packaged in PET reusable bottles (n=12), single use PET bottles (n=10), reusable glass bottles (n=9), single use glass bottle (n=1)	250ml of initial sample volume	0 to 16634 particles/L; mean 3633.26±3860.96 particles/L.	1 µm to >10µm	NA	PET, PET, PE, PP
Schymanski et al. 2018	Returnable plastic bottles (n=15), single-use plastic bottles (n=11), glass bottles (n=9)	700-1500ml	2 to 241 particles/L; particles per L in single-use plastic bottles (14±14), returnable plastic bottles (118±88), glass bottles (50±52)	5 µm to >100 µm;	fragments	PET, PEST, PE, PP, PA, others

* Kosuth et al. 2018 reported "anthropogenic particles" as FTIR was not applied to identify particle composition

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Microplastics in air: Inhalation

Environmental Pollution 221 (2017) 453–458

Contents lists available at ScienceDirect

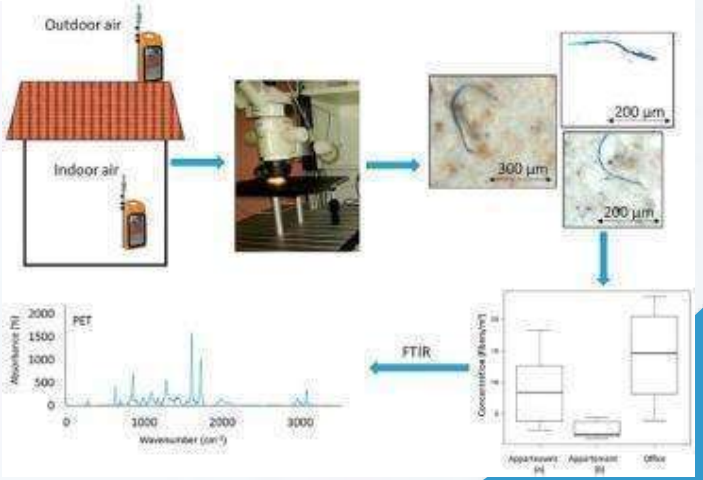
Environmental Pollution

journal homepage: www.elsevier.com/locate/envpol

A first overview of textile fibers, including microplastics, in indoor and outdoor environments☆

Rachid Dris [a, *], Johnny Gasperi [a, **], Cécile Mirande [a], Corinne Mandin [b], Mohamed Guerrouache [c], Valérie Langlois [c], Bruno Tassin [a]

- Indoor concentrations between 1.0 and 60.0 fibers/m^3
- 33% fibers contain petrochemicals with polypropylene being predominant
- There is currently no available data or information which provides evidence of the potential human health effects of ingested or inhaled microplastics.



Microplastics in air: Inhalation

Environmental Pollution 237 (2018) 675–684

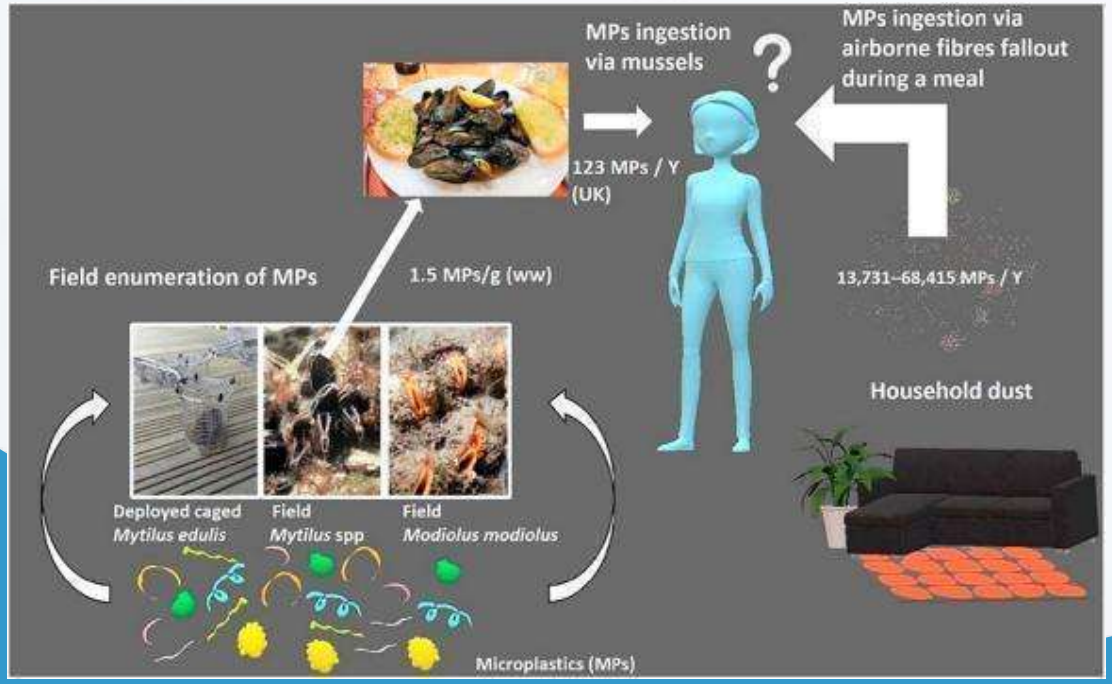
Contents lists available at ScienceDirect

Environmental Pollution

journal homepage: www.elsevier.com/locate/envpol

Low levels of microplastics (MP) in wild mussels indicate that MP ingestion by humans is minimal compared to exposure via household fibres fallout during a meal*

Ana I. Catarino [a, *], Valeria Macchia [b], William G. Sanderson [a, c], Richard C. Thompson [d], Theodore B. Henry [a, e]



'Concerns of human to MPs via shellfish ingestion need to be **placed into context**, since their **potential for ingestion is minimal when compared to exposure to MPs via household dust fallout**'.

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Microplastic Consumption

Environmental Science & Technology

Article

Cite This: Environ. Sci. Technol. 2019, 53, 7068−7074

pubs.acs.org/est

Human Consumption of Microplastics

Kieran D. Cox,*[†,‡] Garth A. Covernton,[†] Hailey L. Davies,[†] John F. Dower,[†] Francis Juanes,[†] and Sarah E. Dudas[†,‡,§]

- Based on caloric intake, estimate that annual MP consumption ~**39,000 to 52,000** particles depending on age and sex, increasing to **74,000 and 121,000** when inhalation is considered.
- Recommended water intake through only bottled sources ingesting an additional 90,000 MPs annually, compared to 4,000 MPs for tap water only.

ACP

Annals of Internal Medicine®

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ORIGINAL RESEARCH | 1 OCTOBER 2019

Detection of Various Microplastics in Human Stool: A Prospective Case Series

Philipp Schwabl, MD; Sebastian Köppel, Dipl-Ing(FH); Philipp Königshofer, DVM; Theresa Bucsics, MD; Michael Trauner, MD; Thomas Reiberger, MD; Bettina Liebmann, PhD

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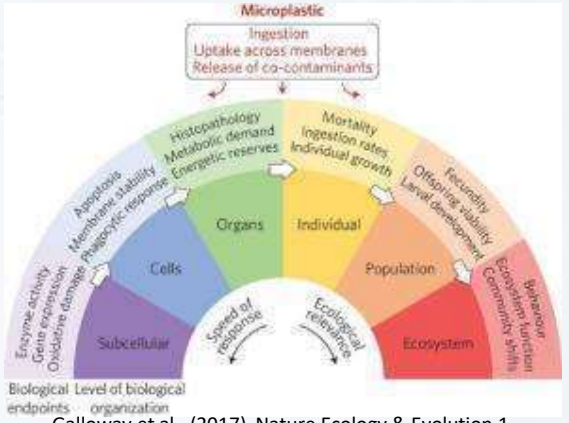
Potential impact of Microplastics on humans

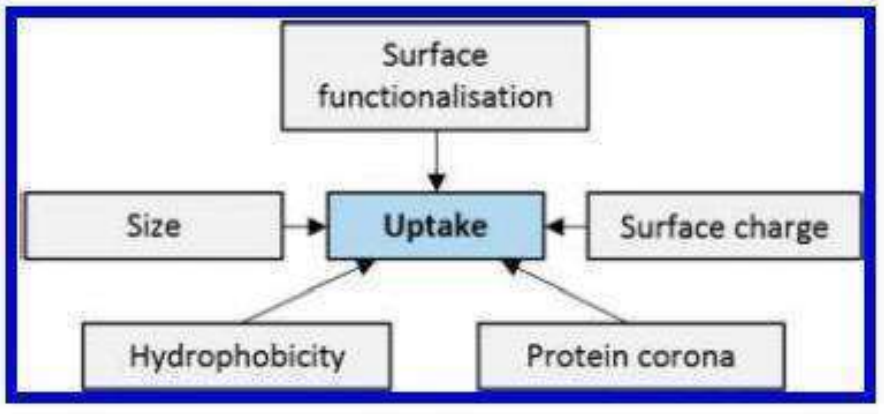
- How to define impact?
- At what level do we assess impact?



Galloway et al., (2017). Nature Ecology & Evolution 1, Article number: 0116

- Potential impacts:
  1. Particle toxicity hazard
  2. Exposure to micromolecules sorbed to MP

- MP physical & chemical characteristics will influence toxicological risk



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Wright SL, Kelly FJ: Plastic and human health: a micro issue? Environ Sci Technol 2017, 51(12):6634-47.

Potential impact: Particle toxicity hazard

- Could lead to a suite of biological responses; inflammation, genotoxicity, oxidative stress, apoptosis & necrosis.
- Potentially leading to tissue damage, fibrosis and carcinogenesis.
- Evidence is provided by wear debris from plastic prosthetic implants.

- PE particles (0.5−50 μm) provoke a non-immunological foreign body response
- PE particles transportation via the perivascular lymph spaces occurs

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Potential impact: Particle toxicity hazard

Science of the Total Environment 684 (2019) 657–669

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Short Communication

An assessment of the toxicity of polypropylene microplastics in human derived cells

Jangsun Hwang [a,b], Daheui Choi [a], Seora Han [a], Jonghoon Choi [b,*], Jinkee Hong [a,*]

- PP particles showed low cytotoxicity effect in size and concentration manner
- However, a high concentration, small sized, DMSO method of PP particles stimulated the immune system and enhanced potential hypersensitivity to PP particles via an increase in the levels of cytokines and histamines in PBMCs, Raw 264.7 and HMC-1 cells.

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Potential impact: Particle toxicity hazard

Environmental Pollution 234 (2018) 115–126

Contents lists available at ScienceDirect

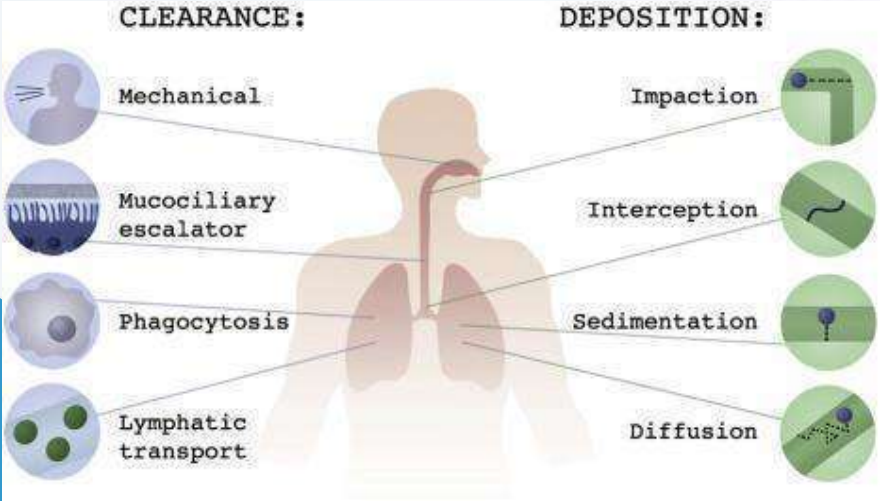
Environmental Pollution

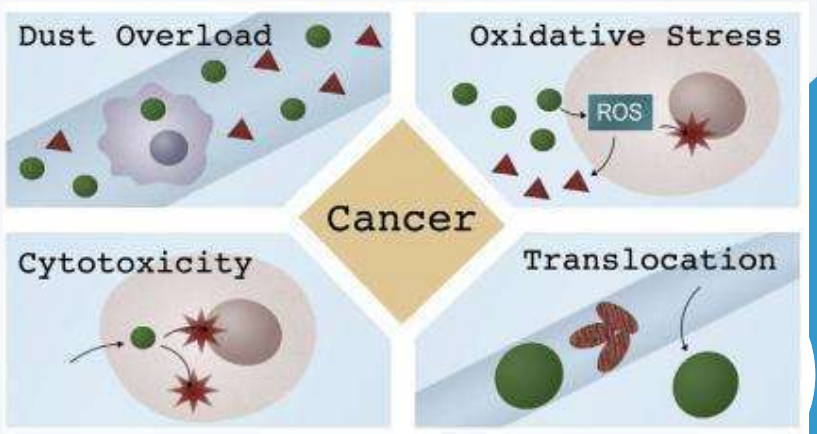
journal homepage: www.elsevier.com/locate/envpol

Airborne microplastics: Consequences to human health?*

Joana Correia Prata

University Fernando Pessoa, Fernando Pessoa Energy, Environment and Health Research Unit (FP ENAS), Praça 9 de Abril, 349, Porto, Portugal





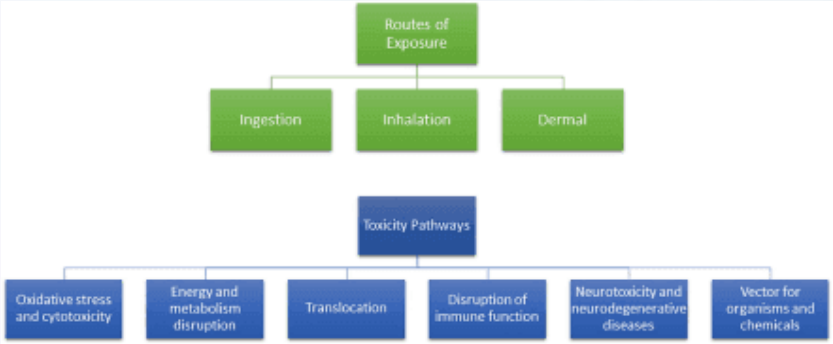
Potential impact: Particle toxicity hazard

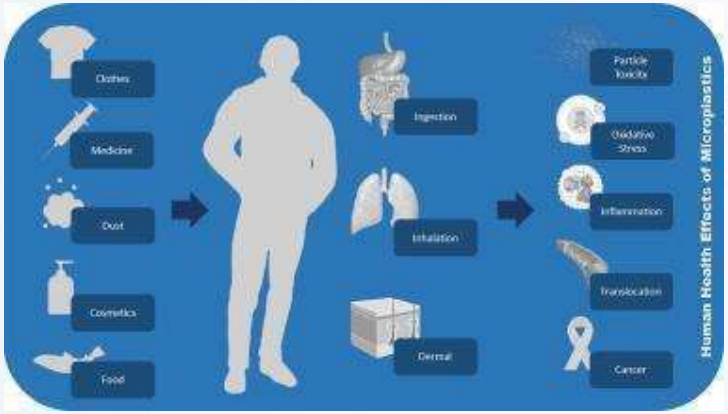
Science of The Total Environment
Available online 4 October 2019, 134455
In Press, Journal Pre-proof

Review

Environmental exposure to microplastics: an overview on possible human health effects

Joana Correia Prata [a], João P. da Costa [a], Isabel Lopes [b], Armando C. Duarte [a], Teresa Rocha-Santos [a]





- Under conditions of high concentration or high individual susceptibility, microplastics **may** cause inflammatory lesions.
- However, **knowledge** on the effects of environmental exposure to microplastics on human health **is limited**, leading to high uncertainties that **should not be translated in alarmism** even when applying the precautionary principle.

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Potential impact: Particle toxicity hazard

Science of the Total Environment 667 (2019) 94–100

Contents lists available at ScienceDirect

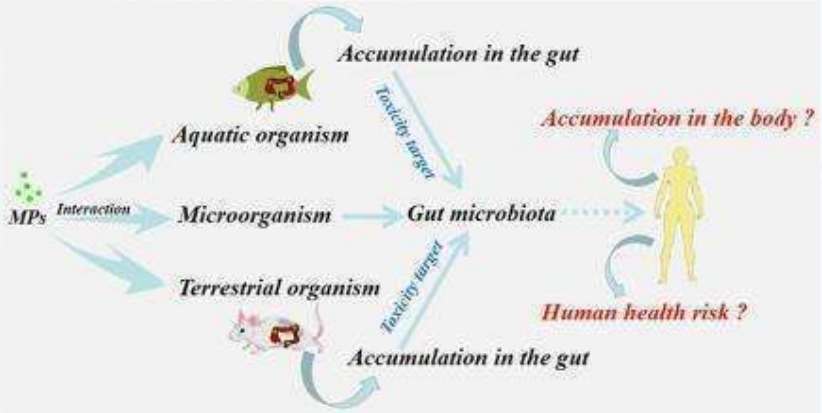
Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Review

Interaction between microplastics and microorganism as well as gut microbiota: A consideration on environmental animal and human health

Liang Lu, Ting Luo, Yao Zhao, Chunhui Cai, Zhengwei Fu, Yuanxiang Jin *



- Microplastics **could** interact with microorganisms as well as gut microbiota.
- Microplastics **may** affect host health through effects on gut microbiota.
- Effects of microplastics on gut microbiota **need more attention**.

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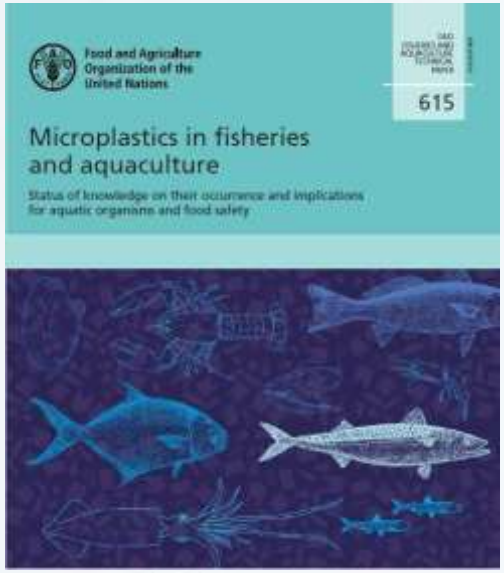
Exposure of micromolecules via microplastics



Exposure assessment using bivalves

Compound	Highest concentration in microplastics (see section 5.6) (ng/g)	Calculated intake from microplastics (pg/kg bw/day)	Total intake from the diet (pg/kg bw/day)	Ratio intake microplastic/total dietary intake (%)
Contaminants				
Non-dioxin like PCBs	2 970	0.3		
EFSA, 2012			4 300[a]	0.007
JECFA, 2016			1 000[a]	0.03
PAHs	44 800	4.5		
EFSA, 2008			28 800[b]	0.02
JECFA, 2006			4 000[c]	0.1
DDT	2 100	0.2		
EFSA, 2006			5 000[d]	0.004
JECFA, 1960			100 000 000[j]	0.0000002
Additives/monomers				
Bisphenol A	200	0.02		
EFSA, 2015a			130 000[e]	0.00002
FAO/WHO, 2011			400 000[f]	0.000005
PBDEs	50	0.005		
EFSA, 2011			700[g]	0.0007
JECFA, 2006			185[h]	0.003
NP	2 500	0.3	NA[i]	
OP	50	0.005	NA[i]	

Note: EFSA (European Food Safety Authority), JECFA (Joint (FAO/WHO) Expert Committee on Food Additives, FAO (Food and Agriculture Organization of the United Nations), WHO (World Health Organisation), PCBs (Polychlorinated biphenyls), PAHs (Polycyclic aromatic hydrocarbons), DDT (Dichlorodiphenyltrichloroethane), PBDEs (Polybrominated diphenyl ethers), NP (Nonylphenol), OP (Octylphenol).

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Exposure of micromolecules via microplastics

Current Opinion in Environmental Science & Health
Available online 11 December 2018
In Press, Corrected Proof

Microplastics in drinking water: A review and assessment

Dafne Eerkes-Medrano [1], Heather A. Leslie [2], Brian Quinn [3]

Compound	Highest concentration in MP (ng/g)	Calculated intake from treated water (pg/kg bw/day)	Calculated intake from tap water (pg/kg bw/day)	Calculated intake from bottled water (pg/kg bw/day)	Total intake from diet (pg/kg bw/day)	Ratio intake treated water MP/total dietary intake (%)	Ratio intake tap water MP/total dietary intake (%)	Ratio intake bottle water MP/total dietary intake (%)
Contaminants								
Non-dioxin like PCBs	2970	0.0026136	12.2364	0.0594				
EFSA, 2012					4300	6.08E-05	**0.28**	**1.38E-03**
JECFA, 2016					1000	2.61E-04	**1.22**	**5.94E-03**
PAHs	44800	0.039424	184.576	0.896				
ESFA, 2008					28800	1.37E-04	**0.64**	**3.11E-03**
JECFA, 2006					4000	9.86E-04	**4.61**	**0.02**
DDT	2100	0.001848	8.652	0.042				
EFSA, 2006					5000	3.70E-05	**0.17**	**8.40E-04**
JECFA, 1960					100000000	1.85E-09	**8.65E-06**	**4.20E-08**
Additives								
Bisphenol A	200	0.000176	0.824	0.004				
EFSA, 2015a					130000	1.35E-07	**6.34E-04**	**3.08E-06**
FAO/WHO, 2011					400000	4.40E-08	**2.06E-04**	**1.00E-06**
PBDEs	50	0.000044	0.206	0.001				
EFSA, 2011					700	6.29E-06	**0.03**	**1.43E-04**
JECFA, 2006					185	2.38E-05	**0.11**	**5.41E-04**

MP concentrations in DW would contribute a small fraction ($8.6x10^{-6}$ to 4.6 % for tap water and $4.2x10^{-8}$ to 0.02 % for bottled water respectively) of the total dietary intake of environmental contaminants and additives.

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Microplastic impact on humans?

Science of the Total Environment 626 (2018) 720–726

Contents lists available at ScienceDirect

Science of the Total Environment

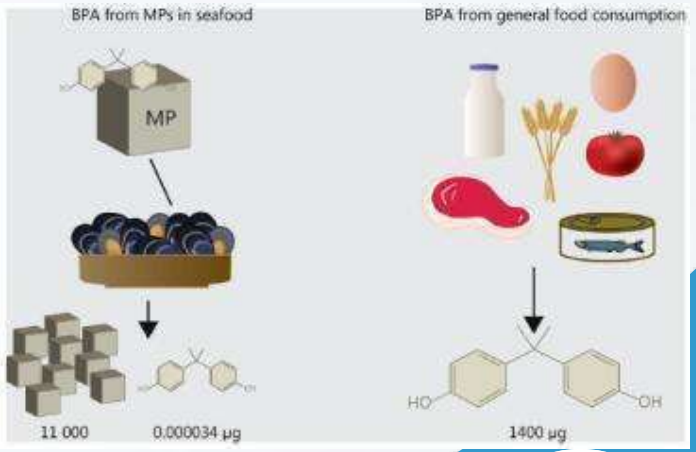
journal homepage: www.elsevier.com/locate/scitotenv

A critical perspective on early communications concerning human health aspects of microplastics

Sinja Rist [a], Bethanie Carney Almroth [b], Nanna B. Hartmann [a], Therese M. Karlsson [c,*]

[a] Technical University of Denmark, Department of Environmental Engineering, Bygningstorvet, Building 115, 2800 Kgs. Lyngby, Denmark
[b] University of Gothenburg, Department of Biological and Environmental Sciences, Medicinaregatan 18A, 41390 Göteborg, Sweden
[c] University of Gothenburg, Department of Marine Sciences, Kristineberg Marine Research Station, 45178 Fiskebäckskil, Sweden

- There is a **big discrepancy between the magnitude of this debate and actual scientific findings**, which have merely shown the presence of microplastics in certain products.
- Microplastics from food products and beverages likely only constitute a **minor exposure pathway** for plastic particles and associated chemicals to humans.
- But as this is **rarely put into perspective**, the recent debate has created a **skewed picture of human plastic exposure.**



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Microplastic impact on humans?

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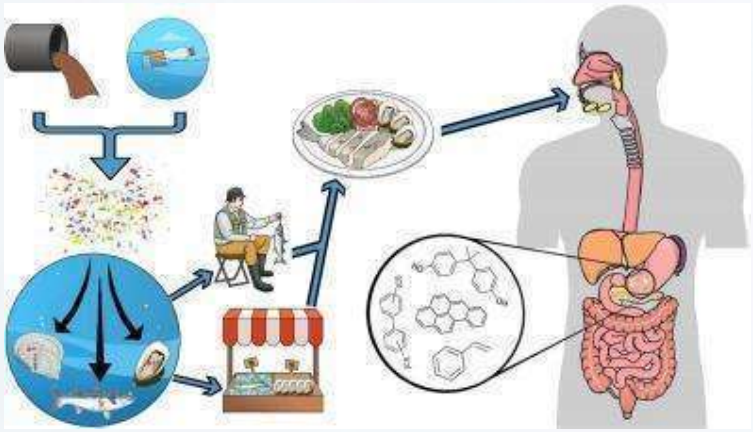
REVIEW ARTICLE

Microplastics: an emerging threat to food security and human health

Gabriel Enrique De-la-Torre[1]



Conclusion and future research

Microplastic pollution in marine environments pose a risk to food security and human health. Research has proven the presence of microplastics in seafood and foodstuff around the world, meaning we are always exposed to microplastic ingestion. Nonetheless, little is known about its direct effects on human health. Future research should focus on microplastic monitoring techniques along the supply chain. There is a lack of information on the extent to which food security is affected by microplastic presence. Finally, plastic waste management must be improved, along with microplastic legislation.

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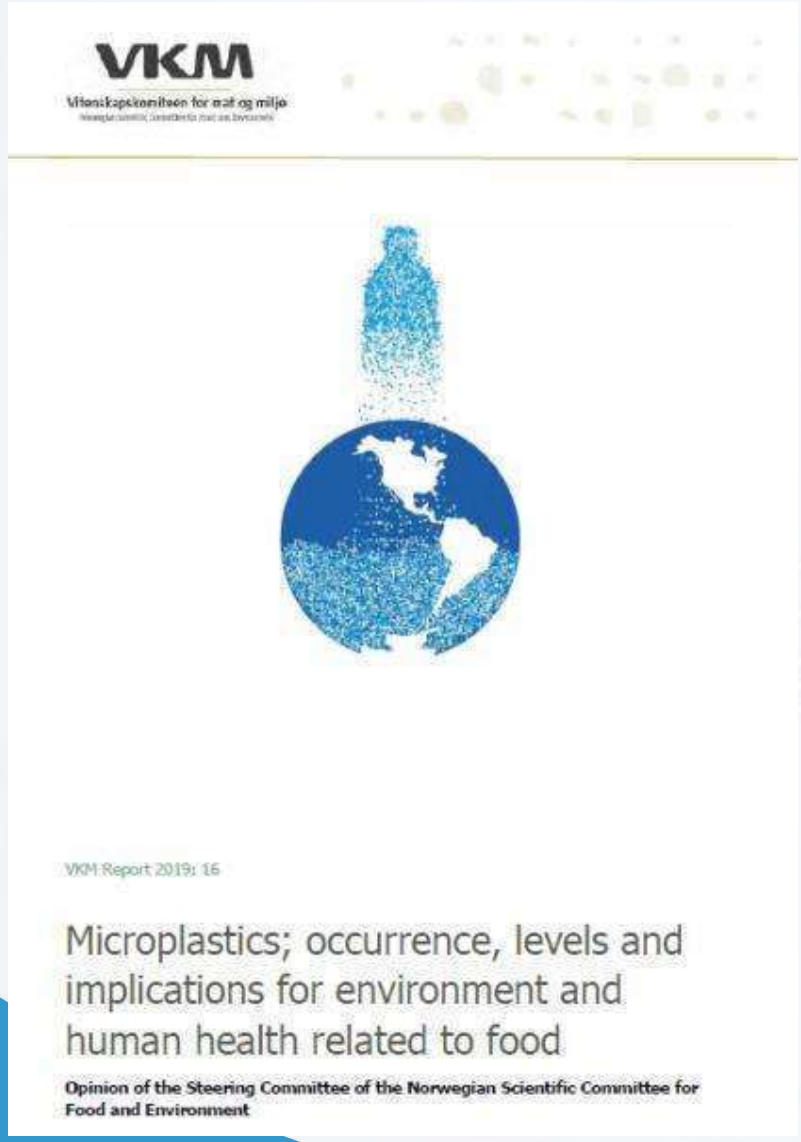

VKM concludes that the **available information does not provide sufficient basis to characterize potential toxicity in humans.**

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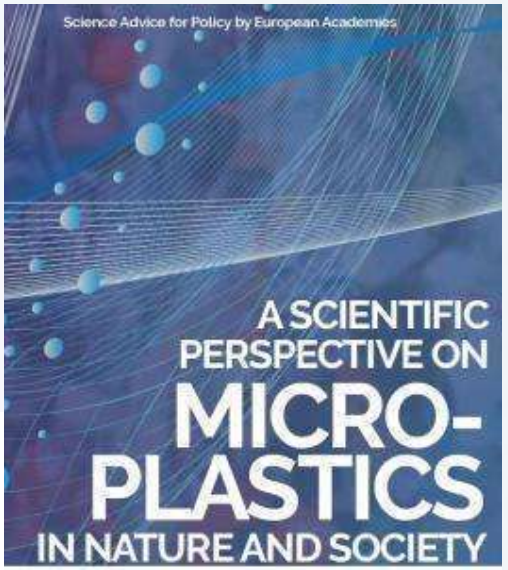
Microplastic and human health: Risk assessment



The 4 Step Risk Assessment Process

Hazard Identification
What health problems are caused by the pollutant?

Dose-Response Assessment
What are the health problems at different exposures?

Exposure Assessment
How much of the pollutant are people exposed to during a specific time period? How many people are exposed?

Risk Characterization
What is the extra risk of health problems in the exposed population?

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Data gaps in both exposure and hazard preclude an adequate risk characterization of MP to humans, via DW or any other route.